1. The Haber process for the production of ammonia is represented by the unbalanced equation $N_2(g) + H_2(g) \rightarrow 2NH_3(g)$. The complete conversion of 9.0 mol of hydrogen to ammonia would require how many moles of nitrogen?

2. In the equation $2KClO_3 \rightarrow 2KCl + 3O_2$, how many moles of oxygen are produced when 3.0 mol of $KClO_3$ decompose completely?

3. For the reaction $C + 2H_2 \rightarrow CH_4$, how many moles of hydrogen are required to produce 10 moles of methane ($CH_4$)?

4. For the reaction $2H_2 + O_2 \rightarrow 2H_2O$, how many moles of water can be produced from 6 moles of oxygen?

ented by the unbalanced equation
nol of hydrogen to ammonia
$H_2 \times \frac{1\,mol\,N_2}{3\,mol\,H_2} = 3.0\,mol\,N_2$

oxygen are produced when
$\frac{3\,mol\,O_2}{2\,mol\,KClO_3} = 4.5\,mol\,O_2$

rogen are required to produce
$\frac{1\,H_2}{1\,CH_4} = 20\,mol\,H_2$

ater can be produced from 6 moles
$= 12\,mol\,H_2O$

Name _____ Class _____ Date _____

# Ideal Stoichiometric Calculations

## Section Review 9.2

**DIRECTIONS:** Write the answer to questions 1–13 on the line to the right, and show your work in the space provided.

1. The Haber process for the production of ammonia is represented by the unbalanced equation $N_2(g) + H_2(g) \rightarrow 2NH_3(g)$. The complete conversion of 9.0 mol of hydrogen to ammonia would require how many moles of nitrogen? _____ 1

2. In the equation $2KClO_3 \rightarrow 2KCl + 3O_2$, how many moles of oxygen are produced when 3.0 mol of $KClO_3$ decompose completely? _____ 2

3. For the reaction $C + 2H_2 \rightarrow CH_4$, how many moles of hydrogen are required to produce 10 moles of methane ($CH_4$)? _____ 3

4. For the reaction $2H_2 + O_2 \rightarrow 2H_2O$, how many moles of water can be produced from 6 moles of oxygen? _____ 4

**DIRECTIONS:** Questions 5–13 refer to the following table.

**TABLE OF ATOMIC MASSES**

| Element | Symbol | Atomic Mass (*u*) |
|---|---|---|
| Hydrogen | H | 1.007 94 |
| Chlorine | Cl | 35.453 |
| Oxygen | O | 15.9994 |
| Sulfur | S | 32.06 |
| Sodium | Na | 22.989 77 |
| Carbon | C | 12.0111 |
| Mercury | Hg | 200.59 |
| Fluorine | F | 18.998 403 |
| Calcium | Ca | 40.08 |
| Cobalt | Co | 58.9332 |

5. For the reaction $2H_2 + O_2 \rightarrow 2H_2O$, approximately how many grams of water can be produced from 6.00 mol of hydrogen? _____ 5

6. For the reaction $C + 2H_2 \rightarrow CH_4$, how many grams of hydrogen are required to produce 3.00 mol of methane ($CH_4$)? _____ 6

7. For the reaction $2HgO \rightarrow 2Hg + O_2$, how many grams of oxygen can be produced from 10.00 mole of mercury(II) oxide? _____ 7

8. For the reaction $H_2 + F_2 \rightarrow 2HF$, how many grams of hydrogen fluoride can be produced from 8.00 mol of fluorine? _____ 8

9. How many moles of $O_2$ will react with 10.0 g of $H_2$ to form water in the equation $2H_2 + O_2 \rightarrow 2H_2O$? _____ 9

10. For the reaction $CaO + SO_3 \rightarrow CaSO_4$, how many moles of calcium sulfate are produced from 40 g of sulfur trioxide? _____ 10

11. For the reaction $Co + F_2 \rightarrow CoF_2$, how many moles of fluorine are required to produce 290.8 g of cobalt fluoride? _____ 11

12. If 40.0 g of sulfur dioxide are formed in the reaction between sulfur and oxygen, what is the mass of oxygen used? _____ 12

13. In the equation $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$, what is the mass of sodium chloride that reacts with 300.0 g of sulfuric acid? _____ 13


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# STOICHIOMETRY: MASS-MASS PROBLEMS

Name _____

1. $2KClO_3 \rightarrow 2KCl + 3O_2$

   How many grams of potassium chloride are produced if 25 g of potassium chlorate decompose?

   _____

2. $N_2 + 3H_2 \rightarrow 2NH_3$

   How many grams of hydrogen are necessary to react completely with 50.0 g of nitrogen in the above reaction?

   _____

3. How many grams of ammonia are produced in the reaction in Problem 2?

   _____

4. $2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$

   How many grams of silver chloride are produced from 5.0 g of silver nitrate reacting with an excess of barium chloride?

   _____

5. How much barium chloride is necessary to react with the silver nitrate in Problem 4?

   _____


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# Mass to Mass Stoichiometry Problems

*In the following problems, calculate how much of the indicated product is made. Show all your work.*

1) $LiOH + HBr \rightarrow LiBr + H_2O$

If you start with ten grams of lithium hydroxide, how many grams of lithium bromide will be produced?

2) $C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$

If you start with 45 grams of ethylene ($C_2H_4$), how many grams of carbon dioxide will be produced?

3) $Mg + 2\ NaF \rightarrow MgF_2 + 2\ Na$

If you start with 5.5 grams of lithium chloride, how many grams of calcium chloride will be produced?

4) $2\ HCl + Na_2SO_4 \rightarrow 2\ NaCl + H_2SO_4$

If you start with 20 grams of hydrochloric acid, how many grams of sulfuric acid will be produced?

[redacted]

# CHEMISTRY HOMEWORK
# MASS - MASS PROBLEMS

Using unit cancellation , solve the following stoichiometric problems.

1. $Fe + S \text{ ----> } FeS$ Fe = 20g , S = Excess , FeS = ?g

2. $NaCl + H2SO_4 \text{ ----> } NaHSO_4 + HCl$ NaCl = 100g , $H_2SO_4$ = excess , HCl = ?g

3. $Al + Fe_2O_3 \text{ -----> } Al_2O_3 + Fe$ $Al_2O_3$ = 57g formed , Al = ?g required

4. $H_2 + N_2 \text{ -----> } NH_3$ 10g = H , $N_2$ = excess , $NH_3$ = ? g.

5. $Ca + HCl \text{ ----> } CaCl_2 + H_2$ 120g Ca , Excess HCl , ?g $CaCl_2$

6. 127 g Excess ? g.
Lead(II) Nitrate + Hydrogen Sulfate ------> Lead(II) Sulfate + Hydrogen Nitrate

7. Excess 34 g ? g
Magnesium + Hydrogen Nitrate -------> Magnesium Nitrate + Hydrogen

8. 10 g excess ? g
Nickel + Hydrogen Chloride -------> Nickel(II) Chloride + Hydrogen

9. ?g 65g
Calcium Carbonate ----> Calcium Oxide + Carbon Dioxide

10. Excess 45 g ?g
Lead(II) Acetate + Hydrogen Sulfide ------> Lead(II) Sulfide + Hydrogen Acetate

11. ?g 250g
Calcium Oxide + Diphosphorus Pentoxide ---> Calcium Phosphate

12. 56g excess ? g
Iron(III) Chloride + Sodium Hydroxide --> Iron(III) Hydroxide + Sodium Chloride

13. excess 42 g ? g
Sodium Hydrogen Carbonate + Hydrogen Sulfate --> Sodium Sulfate + water + Carbon Dioxide

14. 125 g excess ? g
Calcium Hydroxide + Hydrogen Phosphate --> Calcium Phosphate + water

15. 75g excess ? g
. Aluminum Hydroxide + Hydrogen Sulfate ---> Aluminum ~~Phosphate~~ Sulfate + Water

Honors Stoichiometry. All of these Problems Require Balanced Reactions

1. Determine the mass of sodium nitrate produced when 0.73 g of nickel(II) nitrate reacts with sodium hydroxide.

2. What mass of hydrogen peroxide must decompose to produce 0.77 g of water?

3. What mass of carbon monoxide must react with oxygen to produce 0.69 g of carbon dioxide?

4. Determine the mass of carbon dioxide produced when 0.85 g of butane reacts with oxygen.

5. What mass of sodium chloride is produced when chlorine reacts with 0.29 g of sodium iodide?

6. How many grams of ozone ($O_3$) must decompose to produce 0.87 g of oxygen?

7. Determine the mass of lithium hydroxide produced when 0.38 g of lithium nitride reacts with water via Double Replacement

# STOICHIOMETRY: LIMITING REAGENT

Name _____

1. $N_2 + 3H_2 \rightarrow 2NH_3$

   How many grams of $NH_3$ can be produced from the reaction of 28 g of $N_2$ and 25 g of $H_2$?

2. How much of the excess reagent in Problem 1 is left over?

3. $Mg + 2HCl \rightarrow MgCl_2 + H_2$

   What of hydrogen at STP is produced from the reaction of 50.0 g of Mg an the equivalent of 75 g of HCl?

4. How much of the excess reagent in Problem 3 is left over?

5. $3AgNO_3 + Na_3PO_4 \rightarrow Ag_3PO_4 + 3NaNO_3$

   Silver nitrate and sodium phosphate are reacted in equal amounts of 200. g each. How many grams of silver phosphate are produced?

6. How much of the excess reagent in Problem 5 is left?


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# Limiting Reagent Worksheet

*The 5 questions below involve the following reaction: When copper (II) chloride reacts with sodium nitrate, copper (II) nitrate and sodium chloride are formed.*

1) Write the balanced equation for the reaction given above:

2) If 15 grams of copper (II) chloride react with 20 grams of sodium nitrate, how much sodium chloride can be formed?

3) What is the limiting reagent for the reaction in #2? _____

4) How much of the nonlimiting reagent is left over in this reaction?

5) If 11.3 grams of sodium chloride are formed in the reaction described in problem #2, what is the percent yield of this reaction?

1) Write the balanced equation for the reaction of lead (II) nitrate with sodium iodide to form sodium nitrate and lead (II) iodide:

2) If I start with 25.0 grams of lead (II) nitrate and 15.0 grams of sodium iodide, how many grams of sodium nitrate can be formed?

3) What is the limiting reagent in the reaction described in problem 2?

4) How much of the nonlimiting reagent will be left over from the reaction in problem #2?

# Percent, Actual, and Theoretical Yield

1) $LiOH + KCl \rightarrow LiCl + KOH$

a) I began this reaction with 20 grams of lithium hydroxide. What is my theoretical yield of lithium chloride?

b) I actually produced 6 grams of lithium chloride. What is my percent yield?

2) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

a) If I start with 5 grams of $C_3H_8$, what is my theoretical yield of water?

b) I got a percent yield of 75% How many grams of water did I make?

3) $Be + 2\ HCl \rightarrow BeCl_2 + H_2$

My theoretical yield of beryllium chloride was 10.7 grams. If my actual yield was 4.5 grams, what was my percent yield?

4) $2\ NaCl + CaO \rightarrow CaCl_2 + Na_2O$

What is my theoretical yield of sodium oxide if I start with 20 grams of calcium oxide?

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5) $FeBr_2 + 2\ KCl \rightarrow FeCl_2 + 2\ KBr$

a) What is my theoretical yield of iron (II) chloride if I start with 34 grams of iron (II) bromide?

b) What is my percent yield of iron (II) chloride if my actual yield is 4 grams?

6) $TiS + H_2O \rightarrow H_2S + TiO$

What is my percent yield of titanium (II) oxide if I start with 20 grams of titanium (II) sulfide and my actual yield of titanium (II) oxide is 22 grams?

7) $U + 3\ Br_2 \rightarrow UBr_6$

What is my actual yield of uranium hexabromide if I start with 100 grams of uranium and get a percent yield of 83% ?

8) $H_2SO_4 \rightarrow H_2O + SO_3$

If I start with 89 grams of sulfuric acid and produce 7.1 grams of water, what is my percent yield?

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Name _____ Class _____ Date _____

# Limiting Reactants and Percent Yield

## Section Review 9.3

**DIRECTIONS:** Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. The reactant that controls the amount of product formed in a chemical reaction is called the (a) excess reactant; (b) mole ratio; (c) composition reactant; (d) limiting reactant. _____ 1
2. In a chemical reaction, the limiting reactant (a) would be completely used first; (b) would not be completely used; (c) is unreactive; (d) must be in solution. _____ 2
3. In a chemical reaction, the reactant remaining after all of the limiting reactant is completely used is referred to as the (a) product; (b) excess reactant; (c) controlling reactant; (d) catalyst. _____ 3
4. In the reaction A + B → C + D, if there is an insufficient quantity of B to completely react with all of A, then (a) A is the limiting reactant; (b) B is the limiting reactant; (c) there is no limiting reactant; (d) no product can be formed. _____ 4
5. To determine the limiting reactant in a chemical reaction, one must know the (a) available amount of one of the reactants; (b) amount of product formed; (c) available amounts of both reactants; (d) speed of the reaction. _____ 5
6. To determine the limiting reactant in a chemical reaction involving substances A and B, one could first calculate (a) the mass of 100 moles of A and B; (b) the masses of all products; (c) bond energy of A and B; (d) the amount of moles of B required to react completely with A. _____ 6
7. The maximum amount of a product that can be produced from a given amount of reactant is called the (a) percent yield; (b) mole ratio; (c) theoretical yield; (d) actual yield. _____ 7
8. In most chemical reactions the amount of product obtained is (a) equal to the theoretical yield; (b) less than the theoretical yield; (c) more than the theoretical yield; (d) more than the percent yield. _____ 8
9. A chemist interested in the efficiency of a chemical reaction would want to calculate the (a) mole ratio; (b) energy released; (c) percent yield; (d) rate of reaction. _____ 9

**DIRECTIONS:** Write the answer to questions 10–13 on the line to the right, and show your work in the space provided.

10. In the reaction $2H_2 + O_2 \rightarrow 2H_2O$, how many ~~moles~~ g of water will be produced if 76g of hydrogen and 123g of oxygen are available to react? _____ 10

11. In the reaction $Mg + 2HCl \rightarrow H_2 + MgCl_2$, how many ~~moles~~ g of magnesium chloride can be produced from 49.5g magnesium and 67.1g of hydrochloric acid? _____ 11

**DIRECTIONS:** Questions 12 and 13 refer to the following table.

| TABLE OF ATOMIC MASSES | | |
|---|---|---|
| **Element** | **Symbol** | **Atomic Mass (*u*)** |
| Hydrogen | H | 1.007 94 |
| Oxygen | O | 15.9994 |
| Carbon | C | 12.0111 |

12. For the reaction $2H_2 + O_2 \rightarrow 2H_2O$ calculate the percent yield if 860. g of water are produced when 100. g of hydrogen react with 950g of oxygen. _____ 12

13. For the reaction $C + 2H_2 \rightarrow CH_4$, calculate the percent yield if 98 g of methane are produced when 100. g of carbon react with an 100g of hydrogen. _____ 13


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# Answer the following Limiting Reaction and % Yield Problems:

**All Reactions Require a Balanced Equation!**

1. If 21.4 g of aluminum is reacted with 91.3 g of $Fe_2O_3$, the products will be $Al_2O_3$ and iron. What mass of iron will be produced?

2. If 41.6 g of $N_2O_4$ reacts with 20.8 g of $N_2H_4$, the products will be nitrogen and water. What mass of water will be produced?

3. If 16.8 g of CO is mixed under high pressure with 1.78 g of $H_2$, what mass of methanol ($CH_3OH$) will be produced?

4. What mass of NaCl will be produced by the reaction of 58.7 g of NaI with 29.4 g of $Cl_2$ gas if the products are sodium chloride and $I_2$ ?

5. Determine the percent yield for the reaction between 3.74 g of Na and excess $O_2$ if 5.34 g of $Na_2O_2$ is recovered.

6. Determine the percent yield for the reaction between 6.92 g of K and 4.28 g of $O_2$ if 7.36 g of $K_2O$ is produced.

7. Determine the percent yield for the reaction between 82.4 g of Rb and 11.6 g of $O_2$ if 39.7 g of $Rb_2O$ is produced.

8. Determine the percent yield for the reaction between 46.1 g of Cs and 13.4 g of $O_2$ if 28.3 g of $Cs_2O$ is produced.

9. Determine the percent yield for the reaction between 28.1 g of $Sb_4O_6$ and excess C if 17.3 g of Sb is recovered along with an unknown amount of CO.

10. Determine the percent yield for the reaction between 45.9 g of NaBr and excess chlorine gas to produce 12.8 g of NaCl and an unknown quantity of bromine gas.

11. Determine the percent yield for the reaction between 15.8 g of $NH_3$ and excess oxygen to produce 21.8 g of NO gas and water.

12. Determine the percent yield for the reaction between 98.7 g of $Sb_2S_3$ and excess oxygen if 72.4 g of $Sb_4O_6$ is recovered along with an unknown amount of sulfur dioxide gas.

13. Determine the percent yield for the reaction between 46.5 g of ZnS and 13.3 g of oxygen if 18.4 g of ZnO is recovered along with an unknown quantity of sulfur dioxide.